इंटरनेट मानक

Disclosure to Promote the Right To Information

Whereas the Parliament of India has set out to provide a practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, and whereas the attached publication of the Bureau of Indian Standards is of particular interest to the public, particularly disadvantaged communities and those engaged in the pursuit of education and knowledge, the attached public safety standard is made available to promote the timely dissemination of this information in an accurate manner to the public.

“जानने का अधिकार, जीने का अधिकार”
Mazdoor Kisan Shakti Sangathan
“The Right to Information, The Right to Live”

“पुराने को छोड नये के तरफ”
Jawaharlal Nehru
“Step Out From the Old to the New”

IS 7304-2 (1973): Code for fabrication, installation and testing of salt water piping system for shipboard use, Part 2 Non-ferrous systems [TED 17: Shipbuilding]

“ज्ञान से एक नये भारत का निर्माण”
Satyanarayan Gangaram Pitroda
“Invent a New India Using Knowledge”

Act Number 22 of 2005
The Indian Parliament
RIGHT TO INFORMATION

Made Available By
Public.Resource.Org

“ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है”
Bhartṛhari—Nītiśatakam
“Knowledge is such a treasure which cannot be stolen”

BLANK PAGE

BRUTUM FULMEN

IGNORANTIA JURIS NON EXCUSAT

PROTECTED BY COPYRIGHT

IS : 7304 (Part II) - 1973
(Reaffirmed 2002)

Indian Standard

CODE FOR FABRICATION, INSTALLATION AND TESTING OF SALT WATER PIPING SYSTEM FOR SHIPBOARD USE

PART II NONFERROUS SYSTEMS

(First Reprint NOVEMBER 1983)

UDC 629·12·061 : 621·643 [669·2/·8]

© *Copyright* 1975

INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 7 *September* 1975

Indian Standard

CODE FOR FABRICATION, INSTALLATION AND TESTING OF SALT WATER PIPING SYSTEM FOR SHIPBOARD USE

PART II NONFERROUS SYSTEMS

Shipbuilding Sectional Committee, MCPD 1

Chairman	*Representing*
SHRI S. PARMANANDHAN	Ministry of Defence (NHQ)
Members	
CDR S. P. AGARWALA	Ministry of Defence (DGI)
SHRI N. BALASUBRAMANIAN	Voltas Ltd, Bombay
SHRI R. S. MITAL (*Alternate*)	
SHRI D. P. BHATIA	Mukand Iron & Steel Works Ltd, Bombay
SHRI Z. M. BHATE (*Alternate*)	
SHRI A. S. BONDALE	Garden Reach Workshops Ltd, Calcutta
SHRI N. CHAKRABORTY	Ministry of Shipping & Transport
SHRI S. RAGHAVAN (*Alternate*)	
CHIEF MECHANICAL ENGINEER, THE COMMISSIONERS FOR THE PORT OF CALCUTTA	Ports Consultative Organization, New Delhi
CHIEF MECHANICAL ENGINEER, BOMBAY PORT TRUST (*Alternate*)	
SHRI P. L. D'ABREO	Messrs Kamath & D'Abreo, Cochin
SHRI R. A. KAMATH (*Alternate*)	
SHRI V. G. DAMLE	AFCO Ltd, Bombay
SHRI R. D. PARALKAR (*Alternate*)	
DIRECTOR OF NAVAL CONSTRUCTION	Ministry of Defence (NHQ)
DR M. K. GHOSH ROY	Directorate General of Shipping (Ministry of Shipping & Transport)
SHRI B. HILL	Lloyd's Register of Shipping, Calcutta
SHRI D. B. IRANI	Cochin Shipyard Project, Cochin
SHRI T. R. VENKATESWARAN (*Alternate*)	
SHRI H. K. KAUL	Institute of Marine Engineers, Bombay
SHRI G. K. KURIYAN	Central Institute of Fisheries Technology, Cochin
SHRI M. VELU (*Alternate*)	

(*Continued on page* 29)

© *Copyright* 1975
INDIAN STANDARDS INSTITUTION
This publication is protected under the *Indian Copyright Act* (XIV of 1957) and reproduction in whole or in part by any means except with written permission of the publisher shall be deemed to be an infringement of copyright under the said Act.

Indian Standard

CODE FOR FABRICATION, INSTALLATION AND TESTING OF SALT WATER PIPING SYSTEM FOR SHIPBOARD USE

PART II NONFERROUS SYSTEMS

0. FOREWORD

0.1 This Indian Standard (Part II) was adopted by the Indian Standards Institution on 1 October 1973, after the draft finalized by the Shipbuilding Sectional Committee had been approved by the Marine, Cargo Movement and Packaging Division Council.

0.2 This standard (Part II) prescribes the specific requirements for nonferrous salt water piping system in ships. General requirements of salt water piping system are covered in Part I and the specific requirements for ferrous system are covered in Part III of this standard.

0.3 This standard has been prepared to specify recommendations and requirements for salt water piping system in ships with the object of improving their service life.

0.4 In preparing this standard full consideration has been givento the many factors involved, and to current practice regarding these, in the use of both ferrous and nonferrous materials.

0.5 Failure of component parts of salt water piping system may occur due to corrosion/erosion, known as impingement attack, resulting from excessive turbulance. Poor design, workmanship or both, or high nominal water speed may cause this condition. Failure may occur also due to pitting resulting from deposit attack and cracking due to stress corrosion, or by general wastage in the case of ferrous systems.

0.6 Attention should, therefore, be given to the design, fabrication and installation of systems to ensure streamlined flow. In particular, abrupt changes in the direction of flow, mismatched pipe bores, tube bore protrusions and other flow restrictions should be avoided.

0.7 It will be the responsibility of all concerned to ensure compliance with the requirements of statutory authorities as applicable, in addition to the requirements of this standard.

0.8 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard (Part II) specifies the material requirements and fabrication of salt water piping system using nonferrous components.

2. TERMINOLOGY

2.1 For the purpose of this standard, the terms and definitions given in IS : 7304 (Part I)-1973† shall apply.

3. MATERIAL

3.1 The material used for nonferrous systems shall be in accordance with IS : 7304 (Part I)-1973†.

4. FABRICATION

4.1 Pipes, Flanges, Bolting and Fittings

4.1.1 *Pipes* — The standard outside diameters and thicknesses shall be in accordance with IS : 5493-1969‡ an extract from which is given in Table 1.

4.1.1.1 The minimum wall thickness of a pipe may also be determined by the following formula:

$$t = \frac{pD}{2f} + 0{\cdot}8$$

where

t = wall thickness of pipe, mm;
p = working pressure in N/m^2;
D = external diameter of pipe, mm; and
f = permissible stress in N/m^2.

---

*Rules for rounding off numerical values (*revised*).

†Code for fabrication, installation and testing of salt water piping system for shipboard use: Part I General requirements (*under print*).

‡Dimensions for wrought copper and copper alloy tubes.

TABLE 1 SIZES OF TUBES

(*Clauses* 4.1.1 *and* 4.1.2)

All dimensions in millimetres.

OUTSIDE DIAMETER (IN PREFERRED NUMBER SERIES*) (1)	WALL THICKNESS (2)
2	0·5
2·5	0·5, 0·6
4	0·5, 0·6, 0·8, 1
5	0·5, 0·6, 0·8, 1, 1·2
8	0·6, 0·8, 1, 1·2, 1·5
10	0·6, 0·8, 1, 1·2, 1·5
12	0·6, 0·8, 1, 1·2, 1·5
14	1
16	0·6, 0·8, 1, 1·2, 1·5
18	1
20	0·8, 1, 1·2, 1·5, 2
22	1, 1·2, 1·5
25	1, 1·2, 1·5, 2, 2·5
28	1, 1·2, 1·5
32	1·2, 1·5, 2, 2·5, 3
35·5	1·2, 1·5
40	1·5. 2, 2·5, 3, 4
50	1·5, 2, 2·5, 3, 4, 5
63	1·5, 2, 2·5, 3, 4, 5, 6
80	1·5, 2, 2·5, 3,4, 5, 6, 8
100	1·5, 2, 2·5, 3, 4, 5, 6, 8, 10
125	2, 2·5, 3, 4, 5, 6, 8, 10, 12
160	2·5, 3, 4, 5, 6, 8, 10, 12
200	8, 10, 12
250	8, 10, 12
315	8, 10, 12, 16, 20

*IS : 1076-1967 Preferred numbers (*first revision*).

4.1.1.2 For pipe sizes up to and including 50 mm outside diameter some of the thicknesses given in Table 1 may be unsuitable for use with non-manipulative type couplings, that is, couplings in which the pipe is held by the compression ring. Before using this type of coupling the manufacturer shall be consulted to ensure the suitability of the fittings to be used with the pipe sizes given in Table 1. Attention is drawn also to the restriction on the use of aluminium-brass (*see* **4.1.3.1**).

In systems using copper alloy piping in accordance with Table 1, premature failure may occur if mismatch or misalignment of the bores is excessive. To avoid excessive mismatch it is recommended that the end flanges of valves and fittings should be machined properly.

Pipe flanges shall have their bores machined to suit the outside diameter within the allowable capillary brazing tolerance. The outside diameter of both the pipe flanges and flanges of fittings shall be machined concentric to their bores.

4.1.2 *Flanges and Bolting* — Flanges used in piping system constructed in accordance with this standard shall also be in accordance with relevant Indian Standards. Where no Indian Standards exist, it shall be subject to an agreement between the manufacturer and the purchaser. Care shall be taken to ensure that mating flanges are parallel and aligned truly before bolting up.

4.1.3 *Fittings*

4.1.3.1 *Fittings for joining small pipes* — For the assembly of smaller sizes of copper alloy pipes up to and including 50 mm in diameter use of proprietary types of fittings in materials specified in **2.1** may be used. These can be either capillary or compression types with socket diameter tolerances, the capillary may be either integral solder ring type or end feed. The manufacturer's recommendations regarding cleaning, fluxing and heating shall be adhered to for the production of sound joints.

Compression fittings may be either nonmanipulative type in which a ring is compressed onto the outside surface of the tube in the joint, or the manipulative type in which the end of the tube is flared to produce a sound joint. When aluminium-brass tube ends are flared for use with these joints, they shall be stress-relieved prior to fixing in accordance with **4.2.5**. Because of the danger of cracking due to stress corrosion non-manipulative types shall not be used with aluminium-brass pipes.

4.1.3.2 *Branch and T-pieces* — Designs which ensure streamlined flow into branches will reduce turbulence and thus decrease the risk of corrosion by impingement attack. Swept or acute angled branches are therefore preferred to the right-angled type. These may be of the following types:

a) *Castings* — Any of the casting materials specified by **3.1** may be used. When it is impracticable to fit swept or angled branches, T-connections having internal radii at the junction of not less than $d/3$ may be used where d is the diameter of the main pipe. Bore finish shall be smooth and free from any flash, protrusions or sharp edges. For branches of 50 mm diameter and below, proprietary type of T-piece fittings may be used.

b) *Forged fittings* — Any of the wrought materials specified in **3.1** may be used to fabricate fittings by forging or stamping. The minimum thickness at any part of the fitting shall not be less than the wall thickness of the branch pipe to which it is attached. The finished fitting shall be free from internal stresses in the annealed condition (*see* **4.2.5**).

c) *Fabricated branches* — Fabricated branches are those made by methods other than those described in (a) and (b).

d) *Brazed connections* — The selection of brazing alloys shall be according to **3.1**. Brazing shall be carried out in accordance with **4.3.2**.

4.1.3.3 *Deck and bulkhead fittings for small pipes* — For copper alloy pipeline deck and bulkhead penetrations in sizes 50 mm and below, proprietary types of fittings made of materials specified in **3.1** may be used. In addition, with capillary type fittings, the union connection to the deck and bulkhead piece may be a cone or an O-seal type joint.

For watertight deck or bulkhead, the fittings shall be screwed through the deck (or bulkhead) as shown in Fig. 1 and 2.

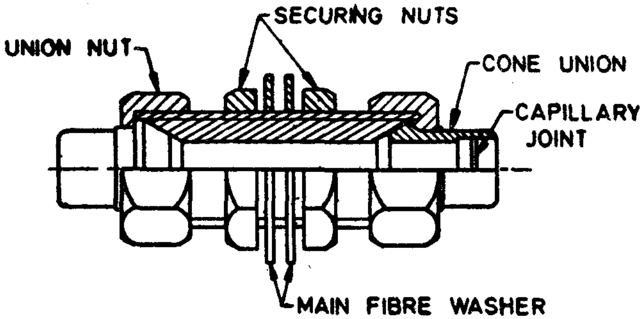


Fig. 1 Cone Joint Deck or Bulkhead Fitting

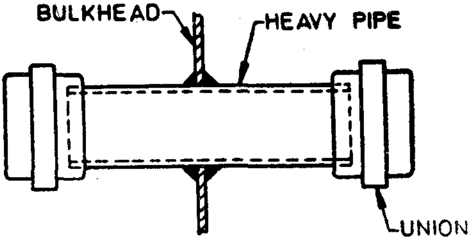


Fig. 2 Bulkhead Fittings for Small Pipes

4.2 Manipulation and Fabrication of Copper Alloy Pipes

4.2.1 *Limits of Pipe Bending and Other Bends* — The centre line radius for bends formed from straight pipes, in the preferred standard thicknesses given in **4.1.1** shall be as large as conditions on board permit. The recommended practice is that the radius shall be not less than three times the outside diameter of the pipe for the continuous flow conditions as defined in **2.1**.

Subject to agreement between the purchaser and the manufacturer, however, a centre line radius less than the preferred minimum radius may be used, in which case, the use of pipes having wall thicknesses more than those given in **4.1.1** shall be made.

4.2.1.1 *Bends* (*short-radius*) — Where short-radius bends are required, proprietary seamless, or seam-welded bends in wrought or cast copper alloys in accordance with **3.1**, may be used.

For pipe sizes up to 50 mm, proprietary fittings according to **4.1.3** may be used.

4.2.2 *Cold Bending of Straight Pipes*

4.2.2.1 Where copper pipes are bent, wall thickness should be 10 percent greater than the thickness arrived at by the formula in **4.1.1.1**.

Extra reliability may be required when the pipes are intended for special applications. Where pipes are easily liable to damage and/or inaccessible during service, special approval of wall thickness may be required.

4.2.2.2 *Machine bending* — It is recommended that tubes shall be bent on a machine preferably with a mandrel attachment or an internal rotary cold rolling head. All tools used in the process shall be appropriate to the size of the tube being bent, and be in good operating condition, free from damage, cracks and other defects. The tools should preferably be confined to use with copper alloys only. A suitable water soluble oil or soap shall be used to lubricate the mandrel during bending as recommended by the manufacturers of the machine.

For larger sizes, generally over 150 mm diameter, if no mandrel is available, a filler material, such as sodium thiosulphate (Hypo) or a synthetic wax, may be used.

Because of the difficulty of complete removal of deleterious residues of resin, or mixtures of resin and pitch fillers, such fillers shall not be used. For removal of filler residues (*see* **4.2.2.5**).

4.2.2.3 *Press bending* — When bending machines are not available or the available machine is not suitable because of the larger diameter of pipes, press bending and manual coppersmithing techniques may be adopted. The filler material used shall be as given in **4.2.2.2**. In these processes, it may be necessary to carry out intermediate (that is, interstage) annealing to complete the bending. Annealing shall be carried out in accordance with **4.2.5**.

4.2.2.4 *General treatment* — Bends made on machines, with or without mandrel attachment, shall be smooth and free from wrinkles. Wrinkles formed on filled tubes which are bent on a machine or by a press shall be dressed before the filler is removed. Bends having sharp wrinkles which cannot be dressed back to form a smooth surface in the throat shall not be accepted. Dressing, which shall be kept to a minimum, shall be carried out by appropriate coppersmithing tools.

4.2.2.5 After the completion of all bending and dressing operations, traces of filler material or mandrel lubricant shall be removed. Residues of water soluble lubricant and sodium thiosulphate filler may be removed by flushing the pipe thoroughly with clean water. If synthetic wax fillers are used, the manufacturer's instructions shall be followed to remove the residues.

4.2.2.6 After the operations in **4.2.2.5** have been carried out, all bends in aluminium-brass shall be stress-relieved in accordance with **4.2.5.** The stress-relieving of bends in cupro-nickel alloys formed on a machine shall be subject to agreement between the purchaser and the manufacturer.

NOTE — If any silver brazing or welding operations are to be carried out adjacent to a bend in a cupro-nickel alloy which has not been stress-relieved, the bend shall be stress-relieved in accordance with **4.2.5** before these operations are carried out to avoid the possibility of stress cracking.

Bends formed by press bending techniques, which normally require dressing, shall be stress-relieved. The stress-relieving of bends in cupro-nickel alloy shall be carried out in accordance with **4.2.5**.

4.2.3 *Hot-Bending of Straight Pipes*

4.2.3.1 Hot-bending of cupro-nickel alloy pipes is not permitted. Aluminium-brass pipes may be hot bent, though this technique is usually restricted to pipe sizes up to and including 100 mm diameter.

4.2.3.2 The pipe shall be filled with clean, dry silica sand, free from metallic or carbonaceous contamination. Hot-bending of aluminium-brass shall be carried out at a temperature range of 600 and 650°C. Bending shall not be attempted in the range of 250 to 550°C, or above 750°C to avoid the risk of cracking.

4.2.3.3 Dry sand filler should be firmly compacted; this operation may be carried out by tapping outside of the tube with rubber or wooden mallets. The sand may also be compacted mechanically using a vibrator table.

This technique is recommended for all pipe sizes, particularly for 100 mm and larger size pipes if hot bending is to be used. Unless sand is adequately compacted poor quality bends will result.

4.2.3.4 Because of the difficulty in dressing back wrinkles in sand filled tubes, the wrinkles should be kept as shallow as possible during bending. Slight opening out of the bend again at the bending temperature will remove moderate to shallow wrinkles, but the sand filler should be re-compacted before continuing hot bending operation. Any shallow wrinkles remaining on completion of the bend may be dressed back at a temperature below 200°C (or cold) as described in **4.2.2.4**. Bends having sharp wrinkles that cannot be dressed back to form a smooth surface in the throat shall not be accepted.

4.2.3.5 The limits of pipe bending are that the centre line radius for bends formed by hot bending techniques shall be in accordance with **4.2.**

4.2.3.6 On completion of the dressing operation the cold-worked portions shall be stress-relieved in accordance with **4.2.5.**

4.2.4 *Welded Copper Alloy Segmented (or Gussetted) Bends* — Segmented bends are not recommended generally, but where their use is unavoidable they shall be fabricated preferably from seamless tubes, and be confined to pipelines of 160 mm diameter and larger. Alternatively, for pipelines of 315 mm nominal diameter and larger, the segments may be fabricated from sheet, cut and rolled to shape.

Segmented bends shall consist of recommended minimum of three segments and they shall be constructed in accordance with **4.3.1.** The centre line radius shall be as large as conditions on board permit. The recommended radius is not less than three times the outside diameter of the pipe, for the continuous flow conditions as defined in **2.1.**

4.2.4.1 Segmented bends consisting of minimum two segments and a centre line radius equal to 1·5 times the outside diameter of the pipe, or less, may be used only for the intermittent flow conditions, as defined in **2.1** and Fig. 3.

4.2.4.2 Segmented bends, consisting of less than three segments and a centre line radius of less than three times the diameter of the pipe may be used only for continuous flow conditions subject to agreement between the purchaser and the manufacturer.

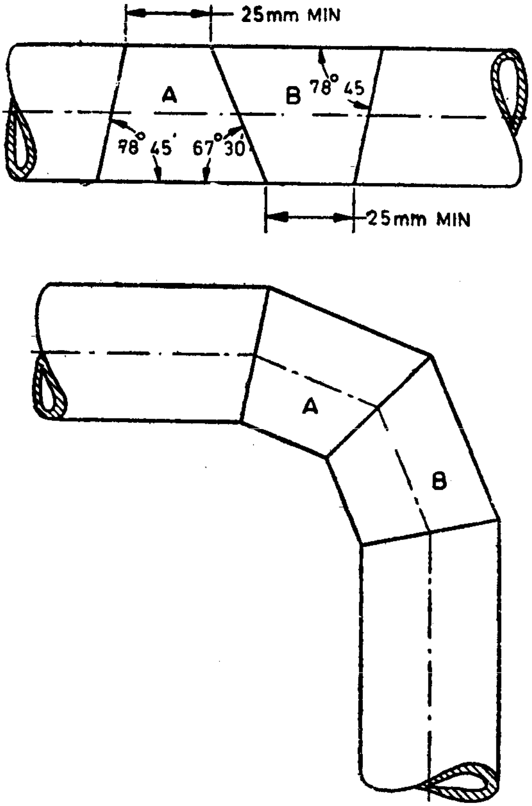


Fig. 3 Segmental (Gusseted) Bend

4.2.4.3 Segmented bends shall have at least one end flanged to facilitate the removal of any excess weld bead penetration, globules, etc, and also to permit the inspection of internal weld bead and general construction of the bend in accordance with the relevant clauses of IS : 7304 (Part I)-1973*.

4.2.4.4 ' Cut-and-shut ' bending techniques shall not be accepted.

---

*Code for fabrication, installation and testing of salt water piping system for shipboard use: Part I General requirements (*under print*).

4.2.5 *Heat Treatment of Copper Alloys*

4.2.5.1 *Stress-relieving* — This treatment does not soften the pipes appreciably but reduces the stresses induced by cold-working operations to a safe level. It shall be carried out preferably in a pyrometrically-controlled furnace at the following range of temperatures:

Aluminium-brass	350-400°C
70/30 Copper/nickel	400-500°C

The temperature of the pipes shall be maintained within the above ranges for not less than 30 minutes. Stress-relieving may also be carried out between the stress-relieving and the annealing temperatures and for appropriate times given in **4.2.5.1** and **4.2.5.2** by agreement between the purchaser and the manufacturer.

Although there is no metallurgical necessity, 90/10 cupro-nickel pipe is sometimes heated after cold-bending prior to placing in service. This annealing is often carried out to remove traces of carbonaceous material from the filler at a temperature range of 600-650°C, a flow of air being supplied at the same time to ensure oxidation of the residues. For a full annealing, that is, to soften for further cold-working, 90/10 cupro-nickel should be heated to 750-800°C. If a low temperature stress-relieving is only required, a temperature range of 350-450°C is recommended.

4.2.5.2 *Annealing* — This treatment softens the pipes and it shall be carried out, when practicable, in a pyrometrically-controlled furnace at the following range of temperatures:

Aluminium brass	600-650°C
90/10 Copper/nickel/iron	750-800°C
70/30 Copper/nickel	800-850°C

The temperature of the pipes shall be maintained within the above ranges for not less than 10 minutes.

4.2.5.3 *Method of heating* — If suitable pyrometrically-controlled furnace is not available, the pipes may be stress-relieved or annealed with one or more suitable torches which shall be adjusted to give an appropriate size of neutral to slightly reducing flame, large enough to heat the pipe uniformly and moderately quickly to the required temperature.

If torch heating is used, temperature-indicating crayons, optical or contact pyrometers shall be used to measure the temperature of the pipe.

For cupro-nickel alloys, sulphur content of the furnace atmosphere shall not exceed 0·25 g/m^3.

NOTE 1 — If fairly heavily cold-worked sections of cupro-nickel alloy are subjected to sudden intense heat, ' fire cracking ' may result.

NOTE 2 — Because of the possibility of the collapsing of large diameter pipes, particularly in aluminium-brass, it is advisable to use supports at the ends of the tubes, when necessary.

4.2.5.4 *Pickling* (*acid cleaning*) — After all hot- and/or cold-working, cleaning and stress-relieving operations have been completed the tubes may be pickled if agreed to between the purchaser and the manufacturer.

If pickling or acid cleaning is necessary, it shall be carried out in a solution of 5 to 10 percent sulphuric acid to which potassium dichromate has been added in the proportion of 25 to 50 g/litre. After pickling, the tubes shall be rinsed thoroughly in hot, fresh water. Other pickling processes may be used subject to agreement between the manufacturer and the purchaser.

4.3 Permanent Joining

4.3.1 *Welding of Copper Alloys*

4.3.1.1 *Filler materials* — Filler materials for arc welding of copper alloys shall be in accordance with **3.1**.

4.3.1.2 *Arc-welding processes* — An appropriate arc welding process shall be selected from Table 2.

TABLE 2 ARC WELDING PROCESSES

ALLOY	BACKING GAS		PROCESS	ROOT RUN		FILLER RUN (IF NECESSARY)	
	Internal Access to Root	No Access to Root		Current Supply	Electrode	Current Supply	Electrode
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Cu-Ni	Not mandatory*	Argon preferred	TIG‡	dc	−ve	dc	−ve
			MIG§	not recommended		dc	+ve
			Manual metal arc	dc	+ve	dc	+ve
Al-brass	Not mandatory†	Not mandatory†	TIG‡	ac‖		ac	
			MIG§	not recommended		dc	+ve

*Backing gas is preferred. Refractory backing rings may be used.

†Painting the inside of the joint with a slurry of silver solder type flux aids formation of a good under-bead profile by deterring zinc volatilization and oxidation.

‡A tungsten electrode diameter of 3 mm or less is recommended.

§For pipe thickness prescribed in this standard, a 1·6 mm maximum diameter wire should be used.

‖Direct current with electrode positive is sometimes possible on thin wall thickness pipes.

4.3.1.3 *Gas welding* — Gas welding is not recommended for copper alloys, and shall be used only by agreement between the purchaser and the manufacturer for cupro-nickels.

Gas welding of aluminium-brass is possible using a matching filler available with fused borax and boric acid flux. The technique is even more difficult with tin bronzes and aluminium bronzes. Matching filler can be used in emergency but for aluminium bronze the flux must contain flourides.

4.3.1.4 *Edge preparation* — Edge preparations shall be such as to ensure a satisfactory weld to be made with the selected welding process or processes. In the case of cupro-nickel alloys the preparation shall be such as to allow at least 50 percent of filler to be deposited at the weld.

The following butt weld preparations are recommended for guidance:

a) *Cupro-nickel alloys* — For thicknesses up to 3 mm the pipe ends to be welded may be machined square and close butted. For pipe thicknesses over 3 mm the pipe end may be prepared to give either a single 'V' of included angle 70° with a feather edge, and no root gap or a V-preparation with a 1·5 mm root face.

   Fusible inserts may be used with either of the recommended preparations.

b) *Aluminium brass* — Up to about 1·5 mm, a square edge preparation with a gap of 1·5 to 2·5 mm is acceptable. For thicker pipe an edge preparation giving a 45° included angle single 'V' with a 1·5 mm root face and 1·5 mm root gap is recommended.

4.3.1.5 *Edge precleaning* — Immediately prior to welding or tacking all copper alloy surfaces shall be scratch brushed to brightness with a clean brush used only for copper alloys and degreased with a non-toxic and non-flammable solvent. The same treatment, using wire wool in place of a scratch brush shall be applied to all filler wire used with the inert gas tungsten arc welding (TIG) process.

4.3.1.6 *Jigs and fixtures* — Internal or external backing rings or clamps may be necessary and tack welding is permitted. The tack welding should be done observing the preparations described for general welding (*see* **4.3.1.4, 4.3.1.5** *and* **4.3.1.7**).

4.3.1.7 *Welding procedure* (*general*)

a) *Cupro-nickel alloys* — The welding procedure shall be such as to introduce a minimum of 50 percent of filler material into the joint. Preheat shall not be used. Interpass temperature shall be kept below 150°C to prevent the drop in fatigue strength. Between passes the weld shall be cleaned as specified in **4.3.1.5**.

b) *Aluminium brass* — This material is hot short and the procedure shall be such as to introduce as short a time at high temperature as possible. Between passes the welds shall be cleaned as specified in **4.3.1.5**.

4.3.1.8 *Weld quality* — The weld metal as deposited shall be free from cracks, gross slag inclusions, gross porosity, cavities and other deposition faults. The weld metal shall be fused properly with the parent metal without serious undercutting or overlapping of the toes of the weld. Tests on completed welds shall be in accordance with the relevant clauses of IS : 7304 (Part I)-1973*.

4.3.1.9 *Requirements for special joints*

a) *Pipe to pipe butt welds* — Butt welds between pipes shall be made in accordance with **4.3.1.1** to **4.3.1.7**.

b) *Flanging of pipes* (*copper alloy flanges*) — Welds made to join flanges to pipes shall be made in accordance with **4.3.1.1** to **4.3.1.7**, appropriate to the alloy. In addition, the fillet leg length shall be not less than 1·5 times the wall thickness of the pipe. Flanges shall be centered on the pipe.

c) *Steel flanges welded to copper-nickel pipes* — Clauses **4.3.1.1**, **4.3.1.2** and Table 2 of this standard shall apply. The welding procedure adopted shall be such that there are no iron-rich surfaces in contact with the liquid in the pipe. The joint shall be finished by complete removal of all excess weld metal, and the sizing of the flange and pipe to the design requirements. After completion of all welding and machining operations of the joint the following surfaces shall be checked for iron content by the ferricyanide test [*see* IS : 7304 (Part I)-1973*]:

   1) The face of the weld down to the innermost extremity of the sealing gasket.

   2) The inside surface of the pipe in the vicinity of the fillet weld.

NOTE — For the guidance of fabricators the following procedure has been known to be satisfactory. Prepare the flange as in Fig 4. Short blast or peen the machined surface of the flange and degrease. This minimizes iron pick-up. Do not scratch brush. Before mounting the flange on the pipe make welds 1, 2 and 3 using any process appropriate to cupro-nickel alloys (**4.3.1.2**) for filler runs. Welding conditions should be such as to keep dilution to a minimum. Any overfilling at this stage should be machined back properly. The flange may now be mounted on the pipe and the remaining welds completed (Fig. 5) including the fillet weld on the back of the flange. Care should be taken with this fillet to avoid burning through the pipe wall. Deviations from this procedure are permitted provided the mandatory requirements of **4.3.1 9** (c) are still met.

d) *Fabricated bends and branches* (*including attachment for branches*) — The welding procedure for the manufacture of these items and their inclusion in the pipe work system shall conform to the requirements of **4.3.1.1** to **4.3.1.6** for the appropriate alloy.

---

*Code for fabrication, installation and testing of salt water piping system for shipboard use: Part I General requirements (*under print*).

e) *Welded connections* — The appropriate welding consumables are given in IS : 7304 (Part I)-1973* and Table 3. Welding shall be in accordance with **4.3.1.** Immediately before welding the formed section of the pipe shall be stress-relieved in accordance with **4.2.5.1.** Inspection in accordance with the relevant clauses of IS : 7304 (Part I)-1973* shall be carried out. In the case of aluminium brass stress-relieving shall be repeated in the same manner.

1) *For continuous intermittent, or no-flow conditions:*

i) *Butt-welded saddle* — With the swept type of branch it is necessary to form the end of the pipe to the required angle. With this type, and the right-angled branch, it is required to manipulate the end of the branch pipe to form a saddle to fit to the main pipe; it may be necessary to carry out inter-stage annealing for which the temperatures given in **4.2.5.2** will apply. A corresponding hole is then cut in the main pipe to the same shape and size as the profile of the saddle portion of the branch pipe. Both profiles are then prepared for butt-welding. An external view of a swept-type branch and a tee-type branch is shown in Fig. 6, 7 and 8.

ii) *Butt-welded stub* (*right-angled tee-type only*) — For this type of branch a stub is formed on the main pipe by the methods described for the formation of a socket in (i). The bore of the stub shall match the bore of the branch pipe, and the wall thickness of the stub shall not be less than the minimum thickness of the branch pipe. The ends of the stub and branch shall be suitably prepared for butt-welding as described in **4.3.1.4.**

iii) *Penetration* — In both (i) and (ii) above the penetration into the bore of the pipe shall not exceed the following limits; 1 mm for branch pipes having a wall thickness up to 1·5 mm, or 80 percent of branch pipe wall thickness when it exceeds 1·5 mm.

2) *Intermittent and no-flow conditions* — Branch connections for these conditions only, may also be of the set-on type, and are prepared by cutting the end of the branch pipe to the appropriate profile to set-on the main pipe. A hole is then cut in the main pipe to match the bore of the profiled end of the branch. For branch pipes having a wall thickness of 2·5 mm and more, the weld preparation of the branch end shall be in accordance with Fig. 9.

---

*Code for fabrication, installation and testing of salt water piping system for shipboard use: Part I General requirements (*under print*).

3) *Penetration* — The penetration into the bore of the pipe shall not exceed 80 percent of the wall thickness of branch pipe.

4) *No-flow condition* — Branch connection of the type described in this clause shall be used only where there is no flow through the branch, for example, thermometer and air vent connections.

5) *Set-on type* — This type of connection may be prepared and welded as shown in Fig. 8.

f) *Fabricated bulkhead pieces* — The designs of these items are shown in Fig. 10A and 10B, the joints which are relevant to copper alloy welding are the fillet welding of a copper alloy flange, of a steel sleeve and of a steel flange to copper alloy pipe. Description of the various joints and attachments are given in Table 4. Welding shall be in accordance with **4.3.1.7**, **4.3.1.8** and **4.3.1.9**.

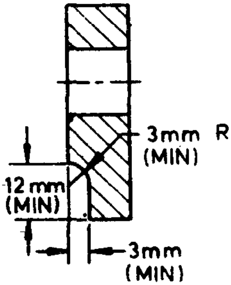
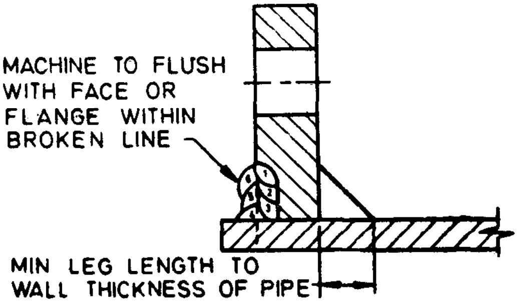


FIG. 4 RECOMMENDED FLANGE PREPARATION



MACHINE TO FLUSH WITH FACE OR FLANGE WITHIN BROKEN LINE
1
2
3
4
5
6
MIN LEG LENGTH TO WALL THICKNESS OF PIPE

FIG. 5 RECOMMENDED WELDING PROCEDURE

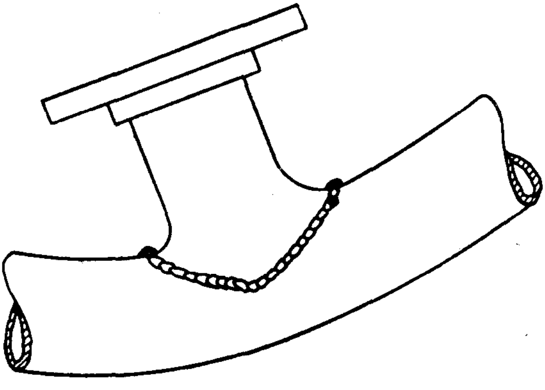


FIG. 6 SWEPT SADDLE TYPE BRANCH

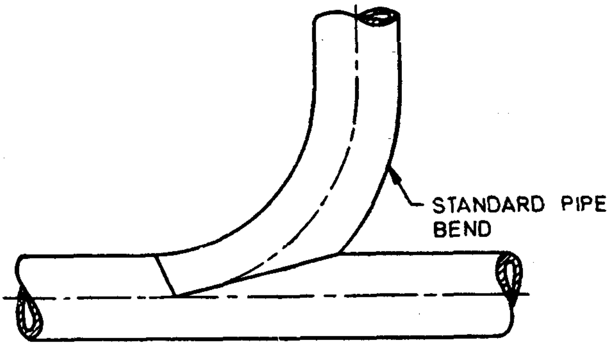


FIG. 7 WELDED BRANCH CONNECTIONS

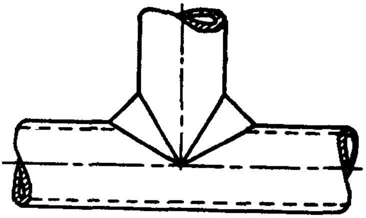


FIG. 8 TEE BRANCH CONNECTION

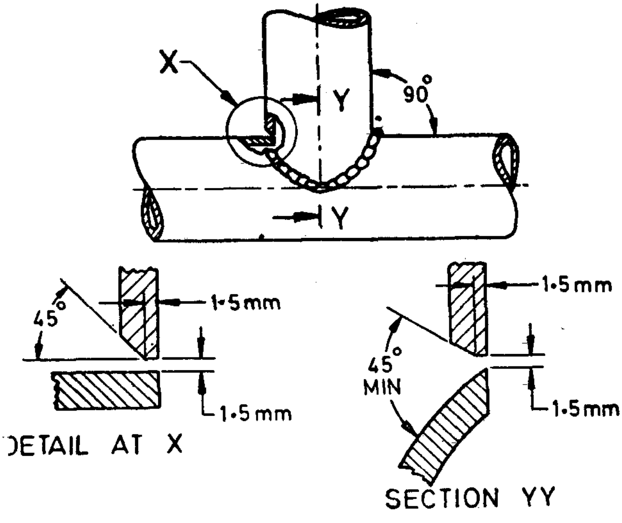


FIG. 9 WELD FOR BRANCH PIPES 2·5 mm WALL THICKNESS AND ABOVE

TABLE 3 FILLER METALS FOR ARC WELDING COPPER ALLOY PIPELINES

[*Clauses* 4.3.1.9(e) *and* 4.4.1]

The table is to be read within a given section along any horizontal path.

For example:

90/10 copper/nickel may be welded to aluminium bronze by IS : 5898-1970 S-Cu Al 2 copper aluminium with Ar or He shielding both on top of and backing the weld by the tungsten inert gas or metal inert gas process.

Parent Metals			Filler Materials*		Shielding Gas		Process
			Indian Standard† Detail	Description	Top	Backing	
90/10 Copper/Nickel	Welded to	90/10 Copper/Nickel	S-Cu Ni 1	90/10/Ti Copper/Nickel	Ar, He	Ar	TIG, MIG
			S-Cu Ni 2	65/30/Ti Copper/Nickel	Ar, He	Ar	TIG, MIG
				70/30 Copper/Nickel	—	Ar‡	Manual Metal Arc
90/10 Copper/Nickel 70/30 Copper/Nickel		Mild Steel	S-Cu Ni 2	66/30/Ti Copper/Nickel	Ar, He	Ar	TIG, MIG
				Monel and 70/30 copper nickel electrode of reputable make	—	Ar‡	Manual Metal Arc
90/10 Copper/Nickel 70/30 Copper/Nickel		Gunmetal	S-Cu Al 2	90/7 Copper/Aluminium	Ar, He	Ar	TIG, MIG
				10% Aluminium bronze with nickel addition of reputable make	Ar‡		Manual Metal Arc

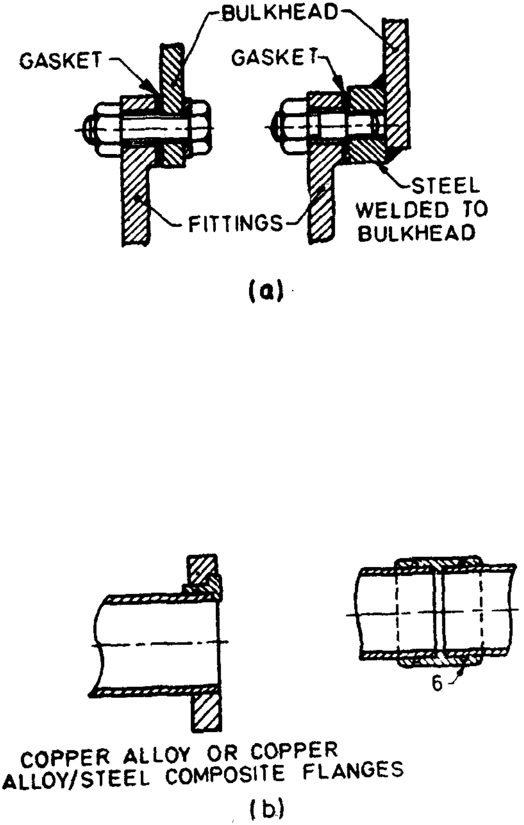
90/10 Copper/Nickel 70/10 Copper/Nickel	Welded to	Cu 10 Al 5 Fe 5 Ni (Aluminium Bronze) Aluminium Bronze	S-Cu Al 2	93/7 Copper/Aluminium make 10% Aluminium Bronze with nickel addition of reputable make	Ar, He —	Ar Ar‡	TIG, MIG Manual Metal Arc
70/30 Copper/Nickel		70/30 Copper/Nickel	S-Cu Ni 2	65/30/Ti Copper/Nickel 70/30 Copper/Nickel of reputable make	Ar, He	Ar, N2 Ar‡	TIG, MIG
2% Aluminium Brass		2% Aluminium Brass	S-Cu Al 2	93/7 Copper/Aluminium	Ar, He	Ar	TIG, MIG
2% Aluminium Brass		Gunmetal	S-Cu Al 2	93/7 Copper/Aluminium	Ar, He	Ar	TIG, MIG
2% Aluminium Brass		Cu 10 Al 5 Fe 5 Ni Aluminium Bronze	S-Cu Al Ni	80/10/5/5 Copper/Aluminium/Nickel/Iron	Ar, He	Ar	TIG, MIG

*Shaped fusible inserts of these or matching analysis composition are permissible for the root. Ceramic tape backing systems, that is, Serbex have been shown to be excellent on some cupro nickels. Not all the combinations in the table have been tried however, and the use of these materials should therefore be subject to agreement between the various contractors and surveyors.

†IS : 5898-1970 Copper and copper alloy bare solid welding rods and electrodes.

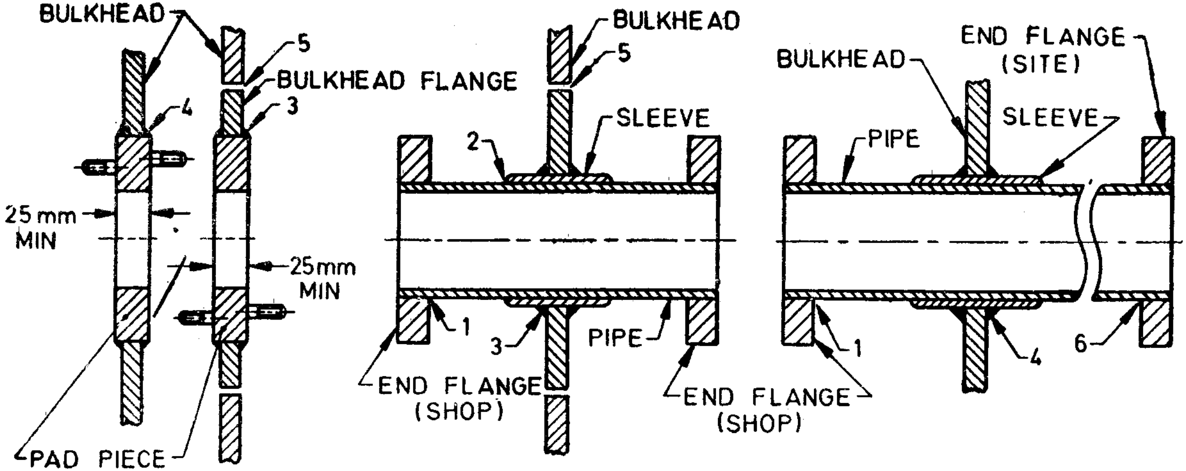
‡Normally manual metal arc electrodes would be used only for the filling runs in which case gas shielding would not apply. In the event that the process was used for root runs gas backing as recommended is considered to be desirable.

Oxygen-free nitrogen may be used as a backing for these materials.



10A Methods of Attaching Fittings to Bulkhead

FIG. 10 FABRICATED BULKHEAD PIECES — *Contd*



TYPE E_1 TYPE E_2 TYPE F TYPE G

10B Copper Alloy/Steel Bulkhead Piece

Fig. 10 Fabricated Bulkhead Pieces

TABLE 4 FABRICATED COPPER ALLOY/STEEL BULKHEAD PIECES METHODS OF ATTACHING COMPONENTS

[*Clauses* 4.3.1.9(f) *and* 4.4.1, and *Fig*. 10B]

Weld or Braze *IN SHOP* | Weld or Braze *ON SITE*

Type	End Flanges (1)*	Sleeve to Pipe (2)	Pad Piece or Sleeve to Bulkhead Flange (3)	Pad Piece or Sleeve to Bulkhead (4)	Bulkhead Flange to Bulkhead (5)	End Attachment (6)
E_1	NA	NA	NA	Pad piece of 90/10 or 70/30 copper nickel metal arc welded to steel bulkhead	NA	NA
E_2	NA	NA	Pad piece of 90/10 or 70/30 copper nickel or aluminium bronze† welded to steel bulkhead flange	NA	Steel bulkhead flange to steel bulkhead a) Lap or butt welded b) Bolted [*see* Fig. 10A(a)]	NA
F	a) Copper alloy flange† Welded or brazed to copper alloy pipe	Steel sleeve a) Welded to 90/10 or 70/30 copper-nickel pipe‡	Steel sleeve welded to steel bulkhead flange	NA		NA
G	b) Steel flange welded to 90/10 or 70/30 copper-nickel pipe [*see* 4.3.1.9 (c)]	b) Brazed to 90/10 or 70/30 copper-nickel or aluminium brass pipe	NA	Steel sleeve welded to steel bulkhead	NA	a) Flange of 90/10 or 70/30 copper-nickel metal arc welded to copper alloy pipe

b) 50 mm and below copper alloy flange or socket capillary brazed to copper alloy pipe [*see* Fig. 10A(b)]

NA = Not Applicable.

*Numbers in column headings refer to Fig. 10B.

†*See* Table 1 of IS : 7304 (Part I)-1973 Code for fabrication and testing of salt water piping system for boardship use: Part I General requirements (*under print*).

‡*See* Testing clause of IS : 7304 (Part I)-1973 Code for fabrication and testing of salt water piping system,for boardship use: Part I General requirements (*under print*).

4.3.1.10 *Heat treatment* — After heavy cold-working and before welding, stress-relieving shall be carried out in accordance with **4.2.5.1.** Aluminium-brass shall also be stress-relieved on the completion of all welding and fabrication.

4.3.2 *Brazing of Copper Alloys*

4.3.2.1 *Brazing consumables* — Consumables shall be chosen from those given in IS : 7304 (Part I)-1973*.

4.3.2.2 *Choice of brazing alloy* — With tubes, as supplied, up to and including 50 mm diameter specified in **4.1.1** and proprietary capillary fittings in accordance with **4.1.3,** the capillary gap is satisfactory for the production of sound joints.

For pipe sizes above 50 mm and where proprietary capillary fittings are not used, and for flanging, the gap between the fittings and the outside diameter of the pipe at any point shall be from 0·1 to 0·2 mm.

This gap may be obtained by the procedure given in **4.3.2.3.**

4.3.2.3 *Methods of achieving gap tolerance*

a) *Flanges* — If the flange bore and the outside diameter of the pipe do not meet the tolerances specified in **4.3.2.2,** the tube may be expanded by means of a mandrel or roller expanders. If circumstances prevent expansion by these methods careful hammering is allowed. With composite flanges, hammering of the pipe end shall not be carried out with the inner ring fitted on the pipe.

b) *All other fittings*

1) If the gap between any of the fittings given in **4.1.3** and the pipe, exceeds the tolerances specified in **4.3.2.2** the pipe shall be manipulated to achieve the tolerances. This situation will most commonly arise with set-on type branches both swept and tee-types and bushes, both set-on and socketed type. The gap fitting brazing alloy is preferred after such manipulation, unless the workmanship is of very high order.

2) For the guidance of fabricators, a method is described below for preparing pipes, branches and bushes for brazing.

   i) *Set-on saddle type* — With the swept type branch, it is necessary to form a bend that is cut to the required angle. With this type and the right-angled branch, it is required to manipulate the end of the branch pipe to form a saddle to fit snugly on the

---

*Code for fabrication, installation and testing of salt water piping system for shipboard use: Part I General requirements (*under print*).

main pipe; it may be necessary to carry out inter-stage annealing, for which the temperatures given in **4.2.5.2** shall apply. A corresponding hole is then manipulated so that there is a satisfactory capillary gap between the saddle and the main pipe. An external view of a tee-branch and a swept branch are shown in Fig. 8 and 11 respectively.

ii) Connections of the type described in this clause shall be used only where there is no flow through the branch, for exarr thermometer and air vent connections.

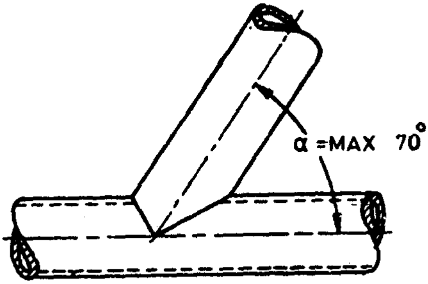


FIG. 11 SWEPT BRANCH CONNECTION

iii) *Set-on type* — This type of boss connections should be prepared and brazed as shown in Fig. 12.

iv) *Socket type* — To form this type of connection a hole is drilled in the main pipe and the area surrounding the hole is locally annealed. A socket is then manipulated with a ' bent pin ', or with a pear-shaped bobbin and steel cable which are pulled through the hole from the inside. Depending upon the size of the socket, it may be necessary to carry out interstage annealing. The thick-walled branch is machined with a spigot which is inserted into the socket to a distance equal to 6 *t* where *t* is the thickness of the main pipe. The arrangement is shown in Fig. 12.

4.3.2.4 *Inspection and testing* — Brazed components shall be visually inspected in accordance with the requirements of IS: 7304 (Part I)-1973*.

---

*Code for fabrication, installation and testing of salt water piping system for shipboard use: Part I General requirements (*under print*).

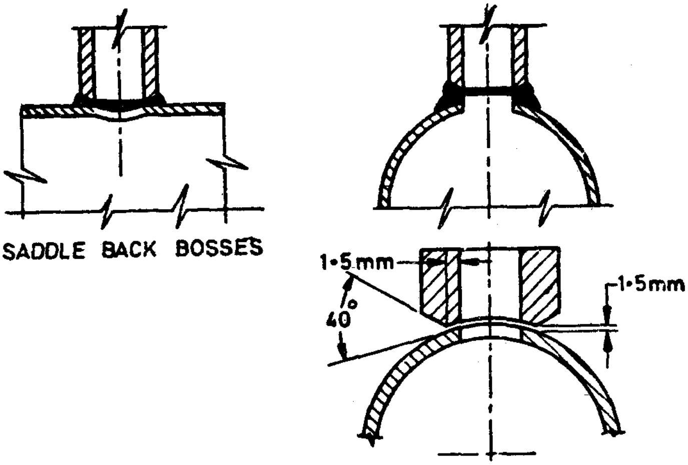


FIG. 12 SET-ON BOSS-WELDED BOSS

4.4 Bulkhead Pieces — Where a pipe has to pass through a bulkhead, it is necessary to attach the pipe to it while maintaining the integrity of the bulkhead. The approved methods are described in **4.4.1** and the choice of design depends upon the accessibility and the space available on the bulkhead itself.

In the cases where it is not acceptable to bolt through the bulkhead, for example, if it has to be watertight, the bulkhead piece shall be as shown in Fig. 10A(a).

4.4.1 *Fabricated Bulkhead Pieces* — Approved methods of construction are shown in Fig. 10B and Table 4.

For type 'E_1' the pad piece may be of a cast or wrought 90/10 or 70/30 cupro-nickel alloy as given in **3.1**, all of which are capable of being welded on site directly to the steel bulkhead using a manual metal arc process given in Table 3. 'E_2' pad pieces are designed for copper alloys which are not easily welded by this process but, nevertheless, may be used provided the pad piece is first shop-welded into a steel flange of the same thickness as that of the bulkhead, when other welding processes given in Table 3 may be used. For this type of pad piece, the flange should be of such diameter as to prevent the overheating of shop-made welds by the heat generated during welding the flange into the bulkhead.

For type ' F ', all the welds shall be made in the shop, and in the case of welding the steel sleeve over the wrought copper alloy pipe, care shall be taken to limit the leg length of the fillet weld to be not more than the thickness of the pipe to ensure that the weld does not penetrate the pipe wall. If the pipe is of 90/10 or 70/30 cupro-nickel, the terminal flange may be of steel and shall be prepared and attached in accordance with **4.3.1.9** (c).

Type ' G ' is similar to type ' F ' except that this method uses the least bulkhead space, but involves site welding of the steel sleeve into the bulkhead and a loose terminal flange of 90/10 and 70/30 copper nickel. The latter welds shall be in accordance with one of the manual metal arc processes given in Table 3.

In types ' F ' and ' G ' where the steel sleeve is brazed to the pipe, the sleeve should be of sufficient length and/or thickness to prevent the heat, generated during welding to the flange or to the bulkhead, from destroying the brazed joint. The site attachment of flanges or sockets by brazing is recommended only for sizes up to and including 50 mm. Above this size all flanges shall be shop-brazed.

4.5 Weed Grids and Strainers

4.5.1 *Weed Grids* — Weed grids shall be fitted at the ship's shell on all sea water inlets to prevent large solids fouling the sea strainers. Preferably the grids shall be mounted with the bars running in a fore and aft direction. The width of clear open space between the bars shall be 15 mm with the ratio of clear grid area to area of sea inlet valve or valves not less than 2 : 1. No part of a grid shall stand protruding over the hull.

Grids may be cast or fabricated, subject to agreement between the purchaser and the manufacturer. Grids shall be secured in position by copper alloy fasteners, securely locked, but it shall be easily dismountable for dry dock inspection.

4.5.2 *Sea Strainers* — Sea strainers, where provided shall be fitted to screen out solids which have passed the shipside weed grids (*see* **4.5.1**). The strainers shall be capable of stopping solids larger than 10 mm diameter, but in certain cases additional, finer filtration may be required. The ratio of clear area through the strainer to the area of sea inlet valve or valves shall not be less than 2·5:1. The strainer shall be capable of being taken out for inspection and removal of trapped solids. Sea strainer bodies may be cast or fabricated with a securely jointed access cover and with a removable perforated screen or cage.

5. INSTALLATION

5.1 The nonferrous system shall be installed in accordance with IS : 7304 (Part I)-1973*.

6. INSPECTION AND TESTING

6.1 Component Inspection and Tests Before Installation — The shop inspection and tests of components for nonferrous system shall be carried out in accordance with IS : 7304 (Part I)-1973*.

6.2 System of Inspection and Tests After Installation — These shall be carried out in accordance with IS : 7304 (Part I)-1973*.

6.3 Sea Trials — Sea trials for nonferrous system shall be carried out in accordance with IS : 7304 (Part I)-1973*.

---

*Code for fabrication, installation and testing of salt water piping system for shipboard use: Part I General requirements (*under print*).

(*Continued from page* 1)

Members	*Representing*
SHRI M. G. KUTTY	Indian Engineering Association, Bombay
SHRI KJELL LINDH	SF India Ltd, Calcutta
SHRI G. SINHA (*Alternate*)	
SHRI S. MAJUMDAR	Directorate General of Technical Development, New Delhi
SHRI K. N. G. MENON	Shipping Corporation of India Ltd, Bombay
CAPT R. D. KOHLI (*Alternate*)	
SHRI I. N. PRADHAN	Indian National Shipowners' Association, Bombay
SHRI T. S. RAJAN	Ericson & Richards, Bombay
SHRI ANJAN ROYE	Institute of Marine Technologists, Bombay
SHRI E. R. DASTOOR (*Alternate* I)	
SHRI K. N. G. MENON (*Alternate* II)	
SHRI S. G. SCHAEFFER	American Bureau of Shipping, Bombay
SHRI K. SHARMA (*Alternate*)	
SHRI D. S. SHETH	Hindustan Shipyard Ltd, Visakhapatnam
SHRI M. G. KUTTY (*Alternate*)	
SHRI T. N. SUJAN	Larsen & Toubro Ltd, Bombay
SHRI K. S. SUBRAMANIAM, Officer on Special Duty (MCPD)	Director General, ISI (*Ex-officio Member*)

Secretary

SHRI V. K. SEHGAL
Assistant Director (MCPD), ISI

Marine Piping Subcommittee, MCPD 1 : 1

Convener	
SHRI D. S. SHETH	Hindustan Shipyard Ltd, Visakhapatnam
Members	
SHRI S. SRINIVASAN (*Alternaet* to Shri D. S. Sheth)	
SHRI A. S. BONDALE	Garden Reach Workshops Ltd, Calcutta
DIRECTOR OF NAVAL CONSTRUCTION	Ministry of Defence (NHQ)
DR M. K. GHOSH ROY	Directorate General of Shipping (Ministry of Shipping & Transport)
SHRI P. L. RAO	Ports Consultative Organisation, New Delhi
SHRI D. K. SEHGAL	Leader Engineering Works, Jullundur
SHRI V. K. PURI (*Alternate*)	
SHRI M. P. SUNDARESAN	The Indian Tube Co Ltd, Jamshedpur
SHRI J. M. TRINDADE	Rajabagan Dockyard of Central Inland Water Transport Corporation Ltd, Calcutta

INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

Quantity	*Unit*	*Symbol*
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

Quantity	*Unit*	*Symbol*
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

Quantity	*Unit*	*Symbol*	*Definition*
Force	newton	N	1 N = 1 $kg.m/s^2$
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m^2
Frequency	hertz	Hz	1 Hz = 1 c/s (s^{-1})
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m^2

INDIAN STANDARDS INSTITUTION

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002

Telephones : 26 60 21, 27 01 31

Telegrams : Manaksanstha

Regional Offices:

			Telephone
Western	: Novelty Chambers, Grant Road	BOMBAY 400007	89 65 28
Eastern	: 5 Chowringhee Approach	CALCUTTA 700072	27 50 90
Southern	: C. I. T. Campus	MADRAS 600113	41 24 42
Northern	: B69, Phase VII	S.A.S. NAGAR (MOHALI) 160051	8 78 26

Branch Offices:

'Pushpak' Nurmohamed Shaikh Marg, Khanpur	AHMADABAD 380001	2 03 91
'F' Block, Unity Bldg, Narasimharaja Square	BANGALORE 560002	22 48 05
Gangotri Complex, Bhadbhada Road, T.T. Nagar	BHOPAL 462003	6 27 16
22E Kalpana Area	BHUBANESHWAR 751014	5 36 27
5-8-56C L.N. Gupta Marg	HYDERABAD 500001	22 10 83
R 14 Yudhister Marg, C Scheme	JAIPUR 302005	6 98 32
117/418 B Sarvodaya Nagar	KANPUR 208005	4 72 92
Patliputra Industrial Estate	PATNA 800013	6 28 98
Hantex Bldg (2nd Floor), Rly Station Road	TRIVANDRUM 695001	32 27

Printed at Seema Offset Press, Delhi, India